

Anonymous Referee #3

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The comment was uploaded in the form of a supplement as follow:

General comments:

This manuscript presents very profound analyses with regard to the aerosol properties in Nanjing, China, using two years of surface-level aerosol observations in combination of coincident meteorological measurements. In particular, the scattering and absorbing properties of aerosols are investigated by linking with RH and visibility, on both diurnal and seasonal scales. The results obtained here gain great insight into how aerosol varies with meteorology, and how scattering aerosol can be differentiated from absorbing aerosols in the highly polluted but populous region of YRD. In this revision, the authors have put more efforts and make thorough changes per the referee's comments, both grammatically and scientifically, which increases its readability. Therefore, I recommend this work be published in ACP after the following concerns have been adequately addressed.

To Referee #3:

Dear reviewer, thank you very much for reviewing the manuscript and providing us the constructive comments and suggestions on our study. We have learned a lot from your advices. With respect to your comments, necessary revisions of the paper have been made. We will response to your comments carefully point by point; details of the revisions can be referred to the revised version of the manuscript.

Relevant changes of the revised manuscript are listed in the last page.

Major points for consideration:

1. What is the difference between "Introduction: lines 63-102" and "description with regard to Table 3 (lines 345-367)", which seems a little redundant. Most of the cited literatures are the same, I recommend the authors delete or shorten the paragraph or rephrase it in the Introduction.

R: Thank you very much for your suggestion. We agree with you that it indeed has a little redundant. The numbers listed in lines 63-102 are mainly aimed at introducing current states and progresses in researching observed based aerosol optical properties over China. In view of these numbers mostly being discussed in the text, lines 63-102 have been shortened in revised manuscript to avoid duplication.

2. Line 475-476: "... three-wavelength integrating Nephelometer (Aurora 3000, Australia) in urban area of Nanjing from Mar 2014 to Feb 2016" contracts with previous statements "because the measurements of Aurora 3000 started from June 2014.", the authors can choose to modify the text to make them consistent with each other.

R: Thank you for your suggestion. According to you advice, Words "from Mar 2014 to Feb 2016" in the sentence have been deleted to make the context consistency in revised version of the manuscript.

Minor points for consideration:

Abstract: "... the regions around." -> "the surrounding regions."

R: It has been corrected in revised manuscript.

Abstract: Line 35: "It" refers to ? clarify it.

R: It means "Atmospheric visibility". Necessary change has been made in revised manuscript.

Line 42: More work can be cited here: "...or global climate changes (e.g., Forster et al., 2007,

Rosenfeld et al., 2008; Li et al., 2011; Wang et al., 2014; Guo et al., 2016)."

References:

Rosenfeld, D., Lohmann, U., Raga, G.B., O'Dowd, C.D., Kulmala, M., Fuzzi, S., Reissell, A., Andreae, M.O.: Flood or drought: how do aerosols affect precipitation? *Science* 321, 5894, 1309-1313. 2008.

Qian, Y., Gong, D.Y., Fan, J.W., Leung, L.R., Bennartz, R., Chen, D.L., Wang, W.G.: Heavy pollution suppresses light rain in China: Observations and modeling. *J. Geophys. Res.* 114, D00K02, doi:10.1029/2008jd011575. 2009.

Li, Z., Li, C., Chen, H., et al.: East Asian Studies of Tropospheric Aerosols and their Impact on Regional Climate (EAST-AIRC): An overview. *J. Geophys. Res.* 116, D7, doi:10.1029/2010jd015257.2011.

Wang, Y., Wang, M., Zhang, R., et al., 2014. Assessing the effects of anthropogenic aerosols on Pacific storm track using a multiscale global climate model. *Proceedings of the National Academy of Sciences* 111, 19, 6894-6899.

Guo, J., M. Deng, S. S. Lee, F. Wang, Z. Li, P. Zhai, H. Liu, W. Lv, W. Yao, and X. Li: Delaying precipitation and lightning by air pollution over the Pearl River Delta. Part I: Observational analyses, *J. Geophys. Res. Atmos.*, 121, 6472–6488, doi:10.1002/2015JD023257.2016.

R: References listed above have been cited in revised manuscript.

Line 58: Grammar error: "The bias is mostly resulted from" -> "The bias mostly results from"

R: Corrected.

Line 60: before "The uncertainty could be substantially", the authors may add one more sentence here as follows: "In addition, the diurnal variability of aerosol properties has been suggested to another major factors leading to such large biases (e.g., Xu et al., AE 2016).

Reference:

Xu H., J.P. Guo, X. Ceamanos, Roujean J.L., M. Min, D. Carrer: On the influence of the diurnal variations of aerosol content to estimate direct aerosol radiative forcing using MODIS data, *Atmospheric Environment*, 141, 186–196. doi:10.1016/j.atmosenv.2016.06.067. 2016.

R: References listed above have been cited and corresponding statements have been included in revised manuscript.

Line 64: "trace gases (Zhang et al., 2009)." -> "trace gases (e.g., Guo et al., 2009; Zhang et al., 2009; Che et al., 2015)."

References:

Guo, J.P., X. Zhang, H. Che, S. Gong, X. An, C.X. Cao, J. Guang, H. Zhang, Y.Q. Wang, X.C. Zhang, P. Zhao, X.W. Li: Correlation between PM Concentrations and Aerosol Optical Depth in Eastern China, *Atmospheric Environment*, 43(37): 5876-5886. 2009.

Xin, J., Wang, Y., Pan, Y., et al.: The Campaign on Atmospheric Aerosol Research Network of China: CARE-China. *Bulletin of the American Meteorological Society* 96, 7, 1137-1155, doi:10.1175/BAMS-D-14-00039.1. 2014.

Che, H. Z., Zhang, X. Y., Xia, X., et al.: Ground-based aerosol climatology of China: aerosol optical depths from the China Aerosol Remote Sensing Network (CARSNET) 2002–2013, *Atmos. Chem. Phys.*, 15, 7619–7652, 2015.

R: References listed above have been cited in revised manuscript.

Line 81: center -> central

R: Corrected.

Line 100-102: “Our ultimate goals are to reduce uncertainties in estimating aerosol radiative forcing and climate effect and to improve forecast accuracy of visibility” SHOULD BE CHANGED because this paper does not contain anything on radiative forcing or climate effect.

R: With respect to your suggestion, the sentence has been rephrased in revised manuscript.

Line 106: “Methodologies” -> “Data and methodologies”

R: Corrected.

Line 117: “To make a brief comparison..” the authors can add more words to clarify “..comparison with what??”

R: It has been changed to “To make a brief comparison between surface and column aerosols”

Line 126: what kind of “Meteorological data”, please give a detailed information here.

R: Thank you for your suggestion. Detailed information has been included.

Line 192: “Eq. 8~10” -> “Eqs. 8~10”

R: Corrected.

Line 207: “Thus, ..., lower boundary height and less rainfall” -> “Thus,.... lower boundary height (Guo et al., 2016) and less rainfall..”

Reference:

Guo, J., Miao, Y., Zhang, Y., Liu, H., Li, Z., Zhang, W., He, J., Lou, M., Yan, Y., Bian, L., and Zhai, P.: The climatology of planetary boundary layer height in China derived from radiosonde and reanalysis data, Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-564, 2016.

R: Reference listed above has been cited in revised manuscript.

Line 209: “RH.” -> “hygroscopic growth of aerosol caused by higher RH..”

R: Corrected.

Line 211: “RH” -> “relatively higher RH”

R: Corrected.

Line 221: “if the moisture absorption growing” you mean “hygroscopic growth”?

R: Yes. And the “moisture absorption growing” has been changed to “hygroscopic growth” in revised manuscript.

Line 224-227: Deleted “which might somewhat relate to a difference in RH in these two years”, and add “The observed RH difference in these two years at least partly accounts for the variation of aerosol absorption coefficient and scattering coefficient as well as their sizes (or sth describing the aerosol properties in previous text)” just following “...69.03 in SON).”

R: Thank you. The sentences have been rephrased based your suggestion.

Line 230: “..at four wavelengths,” is not consistent with text in the first paragraph of Section 3 which states that only one wavelength (i.e., 550nm) will be discussed. So the authors should modify either the statements here or the former statements in section 3.

R: Based on your suggestion. Words “at four wavelengths” have been deleted in revised manuscript.

Line 260: Delete “are”

R: Delete.

Line: 290: “of” is omitted before the statement “ the total samplings...”

R: Thanks. “of” has been added to the sentence.

Line 372: “ obviously” -> “ obvious”

R: Corrected.

Lines 372-374: “ It is obvious..” should be placed behind “ The linear correlation coefficient varies

from 0.93 to 0.97 for SC ... AAC in urban Nanjing."

R: According to your suggestion. This sentence has been placed behind "The linear correlation coefficient varies from 0.93 to 0.97 for SC ... AAC in urban Nanjing."

Lines 377-378: Improper citation: Behind " in the same season in 2011..", add "which agrees well with Yu et al. (2016)"

R: The linear correlation coefficients between SC and AAC and between SC and Bsp in MAM in suburban Nanjing were carried out by Yu et al. (2016). Thus, the reference is cited behind: "...behind suburban Nanjing" So it's appropriate.

Figure 8: Figure caption should better be revised to reflect the monthly variation for the observed aerosol properties.

R: According to your comment, " the monthly variation " has been included in the Figure caption of Fig. 8.

Figure 9b: the legend for the linear fit for SEA should be dashed line

R: Fig. 9b has been redrawn based on your comment.

Relevant changes in revised manuscript:

Author affiliations: #1 and #3 are merged together. The last one is changed to "Department of Climate and Space Sciences and Engineering, University of Michigan, Ann Arbor, Michigan, USA"

In third paragraph of Introduction: Introductions on the aerosol optical properties in lines 70-91 in original manuscript are rephrased and shortened to avoid duplication and confusing, based on the reviewers' comments and suggestions.

In first paragraph of Section 3.2: To make the text more readable, frequency values are listed in a new table (Table 3 in revised manuscript) and corresponding statement has been rephrased according to reviewers' comments.

In fourth paragraph of Section 3.4: Add more discussion on the effect of RH on the aerosol optical properties.

In third and fourth paragraph in Conclusion: According to reviewers' comments, discussions on the importance of the aerosol optical properties seasonal and diurnal variations have been added. Additionally, frequency analysis was shortened.

In Acknowledgements: The foundation number was changed in revised manuscript.

References: References listed and recommended in reviewers' comments were cited and listed in References section in revised manuscript.

In Figure captions: Fig. 8's caption was changed according to reviewers' comments.

Tables: Add a new table (Table 3) to summary the frequencies of the aerosol optical properties. Add a table caption in Table captions section. Table 3 in original manuscript is changed to Table 4.

Figures: Redraw Fig. 9b based on reviewers' comments.

Others: Correct the grammar, cite more references and re-organize some sentences throughout the manuscript according to reviewers' comments.